Relating Plato to the Pythagoreans

The Development of a Software System to Explore the Influence of the Pythagoreans on Plato's Work

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Abstract

This paper gives a brief description of a software system which has been developed in order to facilitate the research that aims to reveal the relation between Plato and the Pythagoreans. There are evidence presented supporting the idea that the influence of the latter on the renowned philosopher impelled him to give a mathematical structure to his writings. The effort to explore such an underlying mathematical structure is complemented in many ways, with the assistance of a computerized tool which is briefly described here, along with some exemplary results from demonstrating the proposed methods of usage to a famous work of Plato, the Symposium.

Keywords

Plato; Pythagoreans; Symposium; Computational Stichometry

Introduction

The influence of the Pythagoreans in thinking and philosophical theory of Plato has been considered particularly catalytic, already since the antiquity, in such a degree that both Aristotle and other contemporaries labelled him as basically a Pythagorean philosopher.

Plato's acquaintance with the Pythagoreans began in Taranto, Italy, in 387 BC, during the trips made by the philosopher after the death of Socrates. Diogenes Laertius (1994) specifically mentioned Plato's acquaintance with Filolaus and Euritus, while in the *Seventh Letter*, attributed to Plato himself, we read about the close friendship developed between himself and Archytas, a still prominent Pythagorean, who has even been argued to be a *"new paradigm philosopher for Plato"* (Vlastos 1991) after Socrates.

The Pythagorean School asserted that the numbers are the components of the substance of the universe. For the Pythagorean philosophers, the numbers, the mathematical relationships and the geometric shapes that are depicted in paper, are the representation of their original models which constitute unique and immutable standards in the human mind. This is the famous Pythagorean teaching of "imitation", according to the saying that everything noticeable is an imperfect imitation of the perfect imaginary world. The influence of this theory in the mind of Plato, for the subsequent development of his own theory about the world of ideas, is obvious. In a further analysis of the Pythagorean philosophy, the basis of this is the so-called "Tetraktys" (see Fig. 1). This is the sum of the first four natural numbers (1 + 2 + 3 + 4 = 10), by which the Pythagoreans argued that the ratios of 4th, 5th and 8th harmonic could be constructed, which in turn created the so-called "Harmony of the Spheres", a tune that governed the universe and could be understood only by philosophers (Kennedy 2011).

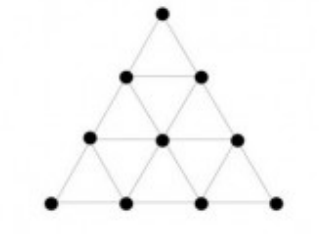

FIG. 1 TETRACTYS

Due to these fundamental theories in the philosophy of the Pythagoreans, it has been argued that they gave a mathematical structure in their writings, as it was believed by Vitruvius. Thus, there are many scholars, so far, who have investigated the potential impact of Pythagorean theories even in the way in which Plato would structure his works, seeking some latent mathematical organization and musicality in his dialogues.

The most recent study of stichometry about Plato was conducted by J. B. Kennedy (2011, 2010), who, considering the dialogues *Symposium* and *Efthyfron*, claims to reveal the musical structure that governs these dialogues. Specifically, the stichometric analysis of Kennedy reveals that *every dialogue can be divided*

into twelve parts, each of which is a symbolic representation of a musical scale of twelve notes (Kennedy 2011).

All the above, combined with the widespread practice of stichometry by the same authors and still for practical purposes, since the period of antiquity as shown by Ohly (1928), was the impetus for the preparation of this paper. The aim is to further investigate the possibility of mathematical organization of the *Symposium* of Plato, and by extension of the Pythagorean influence, with a method of automated stichometry, after producing a relevant computational tool in the programming environment of Visual C# computer language (see Foxall 2008).

Given the large extent of these texts needed to be verified in every such study, the manual method of stichometry, which has been applied until today (with the exception of Kennedy's work, see Kennedy 2010, 2011), namely, the counting of syllables in order to make the arrangement of the initial text in lines of a predetermined number of syllables, as in this case, apart from being very time consuming, poses a high probability of error. Thus, it seemed appropriate to automate this process through the computational implementation of a kind of *syllabifier*, which will provide the user with the ability to make immediate and effective arrangement of the original text into lines of a specified number of syllables, through a user-friendly *graphical user interface (GUI),* and then proceed to conclusions thereon. The core of this computational implementation was based on a number of previous relevant works (Papakitsos 2011, 2009, 2000, 1992). The final software tool has been tested for its overall efficiency to the *Symposium* of Plato, as the "target" text. The results of this application will be presented, later on, in this paper.

The Target-Text

Looking at platonic dialogues from a literary-philological point of view, we can distinguish two major categories:

The first one includes dialogues, in which the discussion is transferred directly from the participants-protagonists themselves (see Bury R.G.), talking successively (usually Socrates and whoever his main interlocutor is, as in *Phaedrus*, *Cratylus*, *Efthyfron*, etc). In this case, each time, the speaker's name precedes his speech.

In contrast, the second category includes those dialogues in which the debate occurs indirectly by a narrator, who either participated himself in the discussion, as attending, or not. So, if the narrator was not an eye witness (or even better a hearsay witness) of those dialogues, this kind of narration includes an additional introductory and a concluding explanatory paragraph. Dialogues like *Theaetetus, Parmenides* and of course the *Symposium* belong to this category, whose narrative levels of the latter are presented in Table 1 (Tzouma 1997).

TABLE 1 THE MULTILEVEL NARRATION OF THE SYMPOSIUM

Level of Narration	Narrator	Auditor
Outer-narrative	Apollodorus	Hetaerus
Inner-narrative	Aristodemus	Apollodorus
Post-narrative	SYMPOSIUM IN THE HOUSE OF AGATHON: Phaedrus, Pausanias, Eryximachus, Aristophanes, Agathon, Alcibiades Socrates (including Diotima)	

Thus, of particular concern at this point is to look into the structure of the *Symposium* that causes the specificity of this dialogue about the narrative technique used by Plato to present the speeches of the different participants. To understand what will follow, the external structure of the *Symposium* should be described, at least broadly.

The structure of the dialogue is masterfully designed. The narration, being layered so to speak, is constructed essentially based on a pair of question-and-answer. Consequently, the prologue begins "in medias res", in the middle of a conversation, after a request that has already been preceded by a company of friends of Apollodorus, to narrate the discussions held in the house of Agathon, about love. Although Apollodorus was not himself present at the symposium, Aristodemus, who had attended as a listener, had narrated in details this event to him before. So Apollodorus accepted willingly to transfer the conversation to his friends, just like he had recently done to Glaucon, when he met the latter on the road from Faliro to Athens. Below are the speeches of all those who attended the symposium:

a) The speech of Phaedrus,
b) of Pausanias,
c) of Eryximachus,
d) of Aristophanes,
e) of Agathon,
f) the speech of Socrates (which includes the words of Diotima as well) and
g) the praises of Socrates by Alcibiades.

The text displays a great complexity in terms of narrative techniques, as shown in Table 1 above, which may hinder the attempt of exploring some of the variations of the text that we thought possible at the computational stage of analysis.

Related Work

The research about the quantitative text analysis of Plato's work has started in the 19th century. Nowadays, before presenting the results obtained from the arrangement of the text of the *Symposium* in lines of specified number of syllables, using the software developed for this purpose (Tsoumaki 2012), it would be appropriate to refer to the most recent research conducted by J. B. Kennedy (2011, 2010), in an effort to reveal a possible stichometric organization of Plato's dialogues.

Kennedy argued that not only the extent of the speeches in the dialogues of Plato and their position within the current text, but also the location of important turns in the arguments of speakers reveals an underlying stichometric organization. In particular, he stressed the importance of a 12-parts structure that the *Symposium* and other dialogues of Plato are shown, as he claimed by even presenting particularly convincing evidence.

In details, a plea of Kennedy is that in dialogues like *Menexenus*, *Phaedrus* and of course the *Symposium*, the speeches of the persons involved are clearly demarcated from the rest of the text. Considering in particular the *Symposium*, he noted that the speeches of Pausanias, Eryximachus and Aristophanes occupy - each one - the 1/12 of the total size of the text, while the speech of Socrates (including the discussions he had with Agathon and Diotima) and that of Alcibiades constitute 3/12 and 2/12 respectively. Thus, he concluded that a ratio of 1:12 was probably of main importance in this work. This is also evidenced by the relative position of these speeches in the text, since for example the beginning of the speech of Pausanias is placed at the 2nd/12 of the dialogue, the beginning of the words of Eryximachus at the 3rd/12 and of Aristophanes at the 4th/12. What is noteworthy is also the fact that the rhetorical fireworks with the praises of Eros within the speech of Agathon, occurs in the 6th/12 of the dialogue, perhaps not a coincidence, since love is the central theme of the *Symposium.*

Similar regularities seem to arise from the comparative study of Plato's dialogues, concerning the relative position within the text, of ideas with positive or negative content. For example, negative ideas like dishonesty, disease, denial, etc. tend to have a certain size and are usually placed between the 10th/12 and the 11th/12 of the total text. In contrast, positive ideas such as virtue, justice, and kindness are shown roughly between the 8th/12 and the 9th/12 of the text.

Besides all the above, the main motivation for the preparation of this work is the assumption (Ohly 1928) that the extent of classical narrative compositions is usually measured by the number of "defined" lines, each of which has a length equivalent to that of a verse of the epic poetry, written in Hexameter. Herein our research work starts. This is because, as it was said, an investigation of possible Pythagorean structure at the *Symposium* will take place after the arrangement of the text in lines of 12 to 17 syllables. The choice of these numbers, however, is not random but directly related to the number of syllables that a verse in Hexameter potentially has (see Table 2).

The Hexameter consists of six feet, each of which has duration of two times (Papakitsos 2011, Halporn, Ostwald & Rosenmeyer 1980). These times are given either by a long syllable and two short-ones (*dactyl*: dactylic foot) or by two long ones (*spondee*: spondaic foot). The last foot, however, is always a spondee, consisting of two long syllables. From the above, it is calculated that the minimum number of syllables of a verse in Hexameter is 12, while the maximum is 17 (see Table 2).

TABLE 2 THE RANGE OF METRICAL PATTERN OF HEXAMETER

Order of Foot	**Type of Foot**	
1st	Spondaic	Dactylic
2nd	Spondaic	Dactylic
3rd	Spondaic	Dactylic
4th	Spondaic	Dactylic
5th	Spondaic	Dactylic
6th	Spondaic	Spondaic
Total of Syllables	12 (= 6 × 2)	17 (= [5 × 3] + 2)
	Minimum	**Maximum**

Data and Preparation

Given our interest in the spatial organization of the ancient scrolls, other parameters in the context of this analysis should be explored, which may lead to alternative forms of the original version of this Platonic work. As claimed elsewhere (Kennedy 2010), the ancient scribes were paid per line and their wages could even be legally safeguarded. Also the cost of a papyrus was partly proportional to its length, while some scholars argued that the ancient literary papyri were of predetermined length and that for this reason

the authors premeditated their compositions to match the scrolls, thus avoiding large gaps (W.A. Johnson did not find evidence for such a tendency in the later papyri of *Oxyrhynchus*, see Johnson 2004). Therefore, even the way of declaring successive speakers in the *Symposium* is a factor that could affect the final outcome, in terms of overall layout of the papyrus. The exploration of these parameters will be attempted next.

The digital variant of the *Symposium*, as the source of the present work, is the text of the ***Perseus*** Digital Library, being accessible to everyone through internet (www.perseus.tufts.edu/hopper/). The first intervention made is the conversion of the polytonal system of writing characters to mono-tonal, for the needs of the software application. This should be done in order to reduce the complexity of the program. This variant, when used without any other changes, includes additional names of speakers in their full within curly brackets (e.g. {Apollodorus}). Also the passages are declared in square brackets (e.g. [172a]). As understood, because the declaration of the passages contains only numbers and letters of the Latin alphabet, it does not affect the counting of the syllables and so it is not necessary to remove these statements from the text. Regarding the names in curly brackets though, they had to be erased as not being part of the original text. After all, by combining two narrative techniques in the text (Tzouma 1997), that of 3rd-person narration ("… Aristophanes said …") and that of dialogue ("Well ... Eryximachus indeed ..."), Plato managed both to inform us about the identity of the speaker and to retain the vitality and immediacy of the narration.

TABLE 3 SYLLABIC PATTERNS OF THE *ALCIBIADES* PAPYRUS

Line order without change of speaker	Number of syllables per line	Line order with change of speaker	Number of syllables per line	
			not including gaps or abbreviated names	aggregation of gaps and abbreviated names
2nd	15	5th	10	12
3rd	15	6th	11	13
7th	14	8th	11	15
9th	15	10th	11	15
11th	16	13th	13	15
12th	13	14th	12	14
16th	15	15th	10	14
17th	15			

The final issue to be addressed is the number of syllables per line of papyri, concerning also the change of speaker. Because the *Symposium* is not particularly helpful in this respect, another work has been examined, that of *Alcibiades*, which will give us an initial indication. The objective of the count is to discover any kind of regularity in the number of syllables per line, whether the lines contain a change of speaker or not. From the sample data of Table 3, it becomes apparent that the particular papyrus does not follow a strict compliance to a specified number of syllables per line. However, it has been observed that the lines not containing a change of speaker have a range of 13 to 16 syllables.

Respectively, it can be seen that the lines containing a change of speaker via a space gap (or an abbreviated name) exhibit a range of 10 to 13 syllables. Conversely, if the count is included in the space gaps as conventional syllables, then the total number of syllables per line comes back again in a range of 12 to 15 syllables. Therefore, it may be concluded that the range of 13 to 16 syllables is the standard pattern that we shall explore further, which is also compatible to the standard pattern of the Hexameter.

The Software Tool

This entire project has been initiated by an original idea of J. B. Kennedy, who suggested the development of such a software system, in order to explore further the issue of Pythagorean structure in the works of Plato. It may be proved whether some ancient philosophers counted the number of syllables per line or not, in order to give a mathematical structure in their work.

The software requirements, as defined by the user of this computational system (Tsoumaki 2012), are listed below:

1) The application should be compatible with the operating system of Windows (versions XP, Vista, 7).
2) The recovery of the digital file of the text of the *Symposium* will be from the hard disk of a user's computer.
3) The users should be able to choose the number of syllables per line in which they wish to split each text.
4) The tool should perform the arrangement of an original text in lines of 12 to 17 syllables and should be able to display the results both on the application window and in a text file that is stored on the hard disk of the user.
5) To facilitate inference on the results, it would be very useful to enumerate the lines of the edited text. In this way, every line can be

absolutely referenced.

Following the previous requirements (1-5), the computer program developed in this work receives a text-file as input (see Fig. 2) plus the desired number of syllables per line of the arranged text after processing.

…… ζώσι και τελευτήσασιν. [180c] Φαίδρον μεν τοιούτον τινά λόγον έφη ειπείν, μετά δε Φαίδρον άλλους τινάς είναι, ων ου πάνυ διεμνημόνευ εν· ους παρείς τον Παυσανίου λόγον διηγείτο. ειπείν δ᾽ αυτόν ότι· ου καλώς μοι δοκεί, ω Φαίδρε, προβεβλήσθαι ημίν ο λόγος, το απλώς …….

FIG. 2 THE LAYOUT OF THE INPUT FILE

The output of the program is another text-file, containing the original text of the input-file, arranged in enumerated lines of the predefined number of syllables, within the range of 12 to 17, as desired by the user (see Fig. 3, for 14 syllables per line).

403 ……
404 ζώσι και τελευτήσασιν. [180c] Φαίδρον μεν τοιούτον
405 τινά λόγον έφη ειπείν, μετά δε Φαίδρον άλ-
406 λους τινάς είναι, ων ου πάνυ διεμνημόνευ-
407 εν· ους παρείς τον Παυσανίου λόγον διηγεί-
408 το. ειπείν δ᾽ αυτόν ότι· ου καλώς μοι δοκεί, ω
409 Φαίδρε, προβεβλήσθαι ημίν ο λόγος, το απλώς
410 ……..

FIG. 3 THE LAYOUT OF THE OUTPUT FILE

The above output is achieved by the main algorithm of the system, which performs counting and spelling, according to the relevant rules.

In counting, the goal is the correct identification of any syllable. For this task, the discovering of vowels is sufficient enough, while the consonants and other marks can be ignored. There are seven vowels in Greek Alphabet (Ancient or Modern alike):

[α, ε, η, ι, ο, υ, ω].

Each one can form a syllable alone. Yet, there are also ten combinations of them in Ancient Greek, the so called *diphthongs*, consisting of two vowels:

[αι, αυ, ει, ευ, ηι, ηυ, οι, ου, υι, ωι].

Each combination counts for only one syllable. Thus, the task here is not counting two syllables, where there is only one. So the main steps of the algorithm are the following (as expressed in a usual pseudo-language for computing purposes):

- Check a/next character.
- IF vowel, THEN increase the number of syllables by one and GO TO the next step, ELSE ignore and RETURN to previous step.
- IF vowel in previous step, THEN check the next character.
- IF the next character is vowel (as well), THEN check for diphthong, ELSE RETURN to the first step.
- IF diphthong in previous step, THEN RETURN to the first step (we don't want to count two syllables here), ELSE increase the number of syllables by one (we have two adjacent vowels not forming a diphthong) and RETURN to first step.

When the desired number of syllables per line is computed, the tool forms a line in the output file and then repeatedly continues for the next line, until the end of the input text-file. But here we may have the case of a word having to be split in two lines. This hyphenation must be performed correctly, which is the task for the spelling module of the tool. This module improves the theoretically correct appearance of the output, but it is not essential for the overall task of the software system, which is the precise counting of the syllables per line.

Other advantages of the system are the following:

- Consistency and simplicity.
- Minimization of the user's activities and immediate feedback.
- Minimization of computing storage.
- Alignment with user's perceptions.
- Flexibility and adaptability.

The performance of the software system reaches a success rate of 100% in the correct counting of syllables and an average of 99.93% in spelling, since only two out of 2996 lines of text (in the 12 syllables per line version) display an error. This performance has been verified manually. The previous error rate is insignificant both compared to the size of the text and the desired goal, since it cannot affect any research conclusions.

Results and Conclusions

Since a mathematical (numerical) structure was determined to be implemented in an author's work, without considering various quantitative patterns of linguistic nature, there are at least four possible ways to do it:

i) by counting the number of written characters,
ii) by counting the number of written syllables,
iii) by counting the number of written words, and
iv) by arranging the text in lines of a particularly chosen pattern.

For example, if Plato, as influenced by the Pythagoreans, desired to give a mathematical structure to his works, based on the Pythagorean sacred number 12, he would have to do it via one of the above ways.

Regarding the first way (i), having Plato's work *Symposium* as the examined text, J. B. Kennedy has presented an underlying mathematical structure, which is summarized in the next table (Table 4), constituting the initial hypothesis of our research.

TABLE 4 STRUCTURE BY CHARACTERS

Speech of	Proportion/Size	Initiating position
Pausanias	1/12	2nd/12
Eryximachus	1/12	3rd/12
Aristophanes	1/12	4th/12
Agathon	3/12	
Socrates (including Diotima's words)		
Alcibiades	2/12	

Regarding the second way (ii), by using the developed computational tool, it is measured that the Symposium consists of 35,941 syllables. According to this total, the *Symposium* does not demonstrate any significant mathematical structure compared to the previous one, as presented in the following table (see Table 4: Proportion/Size vs. Table 5: Ratio).

TABLE 5 STRUCTURE BY SYLLABLES

Speech of	Number of syllables	Ratio
Pausanias	3,317	1 / 10.8
Eryximachus	2,371	1 / 15.2
Aristophanes	3,214	1 / 11.2
Alcibiades	5,105	1 / 7.0

Regarding the third way (iii), the *Symposium* consists of a total of 17,991 words. Considering this, the ratios of the above speeches in number of words are presented in the next table (Table 6).

TABLE 6 STRUCTURE BY WORDS

Speech of	Number of words	Ratio
Pausanias	1,579	1 / 11.4
Eryximachus	1,149	1 / 15.7
Aristophanes	1,536	1 / 11.7
Alcibiades	2,601	1 / 6.9

These ratios are very close to the ones of the previous table (Table 5). Except for the ratio's proximity between the speeches of Pausanias and Aristophanes in both tables, only the speech of Aristophanes is close to the proportion of 1/12 (see Table 4). Yet, the overall picture is that neither this way conforms to the initial hypothesis. Finally, the outcome of the last way (iv) is presented in the following table (Table 7) and commented below.

The first observation is that the ratio of each speech (Table 7: Ratio per S/L) is approximately the same, no matter how many syllables per line the text is arranged (including the structures of 12 and 17 syllables per line, which are not presented in Table 7), as expected. This ratio is almost the same to the one of the second way (see Table 5: Ratio) and it is presented only for comparison purposes to the other ways. So far, the initial hypothesis is not verified by this way either.

TABLE 7 STRUCTURE BY LINES OF FIXED NUMBER OF SYLLABLES

Syllables/Line (S/L)	13	14	15	16	Ratio per S/L
Total lines per case	2765	2568	2397	2247	
Speech of	Number of lines per speech				
Pausanias	255	237	221	207	1/ 10.8
Eryximachus	183	170	158	148	1/ 15.1
Aristophanes	247	230	214	201	1/ 11.2
Alcibiades	393	365	340	319	1/ 7.0

Another possible way to examine the structure of the *Symposium*, regarding the fourth way, would be not having a fixed number of syllables per line, for the entire extent of the text. Namely, the average number of syllables per line would differ from one speech to another, but still within the range of 12 to 17, aiming to conform to the initial hypothesis. This notion is consistent with the one presented in Table 3. In this manner, the speeches of Pausanias, of Eryximachus and of Aristophanes, should occupy the same number of lines (the 1/12 of the total lines), while the speech of Alcibiades should occupy double this number. Let us call this number "NoL". In such a way, the desired outcome is depicted in the next table (Table 8).

TABLE 8 STRUCTURE BY LINES OF VARIED NUMBER OF SYLLABLES

Speech of	Pausanias	Eryximachus
Total syllables per speech	3317	2371
Average number of syllables per line	N_1	N_2
NoL	$3317/ N_1$	$2371/ N_2$
Speech of	Aristophanes	Alcibiades
Total syllables per speech	3214	2552 (= 5105/2)
Average number of syllables per line	N_3	N_4
NoL	$3214/ N_3$	$2552/ N_4$

To examine the mathematical possibility of the above proposal, the NoL between the highest and the lowest values of the ratio should be computed, which are those of Pausanias and Eryximachus:

$$3317/ N_1 = 2371/ N_2 \rightarrow 3317/2371 = N_1/ N_2 \rightarrow$$

$$N_1/N_2 = 1.40 .$$

The above result (1.40) could have been verified only if the speech of Pausanias consists of 17 syllables per line ($N_1 = 17$), while the one of Eryximachus consists of 12 syllables per line ($N_2 = 12$), since {17/12 = 1.42}. The normal range of values, though, according to Table 3, is from 13 to 16, giving a result of 1.23 (=16/13). Thus, it is suggested here that the previous proposal is highly unlikely.

In conclusion, none of these ways of text structuring, except the first one (i), does show interesting results for the *Symposium*. It is doubtful though if any particular text could have been structured in many ways simultaneously, so the appeared failure of the ways (ii) – (iv) is rather expected. There is also the possibility that an author may follow a different way to structure a different work. To reveal whether an author proceeded to similar structures or not, it is essential to explore all of them. The main purpose of this paper was to suggest more than one way to conduct this exploration, by demonstrating the proposed methodology having the *Symposium* as the test example. The *Symposium* was chosen because one method (i) had already been applied to (before the present work), consequently, the demonstration and the comparison to the rest of them would have been easier and more clear. In this respect, the contribution of a computerized tool is invaluable, as it was hopefully demonstrated in the present paper, along with the essential (the authors claims also most enjoyable) interdisciplinary collaboration between Software Engineering and the Arts & Humanities.

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